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(54) Title: PIPE STRUCTURE AND METHOD OF MANUFACTURE

(57) Abstract

A pipe section formed of a polymeric material which has a substantially constant thickness throughout, the terminal edge of the female connection having a reinforcement structure which rigidifies the end of the female connection and prevents deformation, the pipe section preferably having a flared end, and the reinforcement structure preferably being a semicircular channel formed at the end of the pipe section by a mandrel after initial extrusion of the pipe section; along with a method and apparatus for forming the pipe section, a pipe assembly including such pipe section, and a method of forming the pipe assembly.

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PIPE STRUCTURE AND METHOD OF MANUFACTUREField of the Invention

This invention relates to pipes made from polymeric material, and more particularly to pipes made as segments which are assembled into larger pipe systems during installation.

Background of the Invention

During recent years, it has become more and more common for pipes for the transmission of fluids to be made from plastic materials.

Non-metal materials are made into various types of pipes by several methods.

- 10 For instance, it is known to extrude PVC into various shaped pipes. Another more economical method is the corrugated pipe technique, which uses blow mold and vacuum mold techniques to produce a pipe which is formed as extruded tubes of a polymer such as HDPE (high density polyethylene). Systems for fabricating such corrugated pipes are sold by Corma, Inc. of Concord, Ontario. A system of this type
- 15 is also described in U.S. Patent No. 5,296,188, which is herein incorporated by reference.

Polymer material pipes are generally manufactured as continuous extrusions which are then cut into sections. Frequently, each section has a male end and a female end, and these sections are linked sequentially across the distance needed for

- 20 the pipe to extend. The female end of the pipe, sometimes called a bell, receives the male end, sometimes called a spigot, of the next pipe therein.

One problem presented in such pipes derives from the fact that, during fabrication, the material from which the pipe is made is heated, and then cooled. As different portions of the pipe cool and shrink at different rates, stresses are created. If

- 25 the pipe is then exposed to heat, even such as that of strong sunlight, it may cause enough warming to soften portions of the pipe.

The result of this is that portions of the bell are altered from the desired shape. As a result, the bell, which is optimally an open flared cone or skirt with a circular mouth, "flowers", i.e., deforms into a roughly clover-leaf or flower cross-section.

- 30 This flowered structure presents problems when the pipe sections are to be assembled, since the puckering of this shape may make the female end of the pipe too small to easily accommodate the male end of the next pipe section. This means that the

construction crew must try to pry the flowered bell apart to insert the male portion. This is inefficient in terms of labor costs and time. Moreover, the flowering can render the pipe section completely unusable.

Similarly, stacking of the pipe section can create loads in the female end of the 5 pipe section. If environmental factors such as heat created by sunlight or high ambient temperatures are present, this can soften the material to the degree that deformation occurs.

Objects and Summary of the Invention

It is therefore an object of the invention to provide a pipe section having a 10 female end with a strengthened periphery.

It is also an object of the invention to provide a pipe section with a female end resistant to deformation.

It is another object of the invention to provide a pipe section which is readily connected with another pipe section to form a pipe assembly.

15 It is still another object of the invention to provide a pipe assembly which is efficiently and cost-effectively fabricated in the field and is reliably sealed against leakage.

It is a further object of the invention to provide a method and apparatus for making the pipe section of the invention.

20 It is yet another object of the invention to provide a method of fabricating the pipe assembly of the invention.

Accordingly, in one aspect the invention is a pipe section which comprises a segment of polymeric material configured as a conduit having an end strengthened by a reinforcing structure formed integrally of said material around the periphery of said 25 end.

In another aspect, the invention is a pipe assembly for accommodating fluid flow therethrough, which includes a first pipe section comprising a segment of polymeric material configured as a conduit and having a male end and a female end, said first pipe section's female end being flared and being strengthened by a 30 reinforcing structure formed integrally of said material around the periphery of said female end, and a second pipe section comprising a segment of polymeric material configured as a conduit and having a male end and a female end, said male end of said

second pipe section being in the female end of the first pipe section such that fluid may flow from one of said sections into the other.

In a further aspect, the invention is a method of forming a pipe section, which comprises subjecting an end of a segment of polymeric material configured as a conduit to conditions sufficient to render the material proximate such end plastic, and turning the plastic polymeric material at such end back away from the end to form an integral reinforcing structure.

In yet another aspect, the invention is method of fabricating a pipe assembly for accommodating fluid flow therethrough, said assembly including a first pipe section comprising a segment of polymeric material configured as a conduit and having a male end and a female end, said female end being flared and being strengthened by a reinforcing structure formed integrally of said material around the periphery of said female end, and a second pipe section comprising a segment of polymeric material configured as a conduit and having a male end and a female end, which method comprises bringing the female end of said first pipe section and the male end of said second pipe section into approximate registration by inserting the male end of the second pipe into the flared female end of the first pipe section, and connecting the male end of the second pipe section and the female end of the first pipe section when the two sections are in alignment, such that fluid may flow from one of said sections into the other.

In still another aspect, the invention is an apparatus for forming a reinforcing structure on an open end of a polymeric pipe section, which has a mandrel having a wall for contacting said pipe section. The mandrel includes a first portion wherein the wall is configured to be received in the open end of the pipe section, and another portion in which the wall extends outwardly of the first portion in arcuate fashion such that an annular pocket is formed. The apparatus has means for holding the pipe section in an orientation such that it and the mandrel can be brought into contact, with the mandrel's first portion being first received in the opening at the end of the pipe section. The apparatus also has means for causing movement of the mandrel and the pipe section holding means relative to one another such that the mandrel and the pipe section come together with the mandrel's first portion being received by the opening at the end of the pipe section, and thereafter the annular pocket of the third portion

coming into contact with and deforming the end of the pipe section to form a reinforcing structure.

Of course, it will be understood that the invention pertains not only to straight-line pipe sections but also to all other configurations, such as elbow-shaped or T-shaped fittings.

Substantial benefits are conferred by practice of the invention. The provision of a reinforcing structure integral with the subject pipe section, proximate the periphery of the female end, effectively strengthens the structure so that it maintains its desired shape, resists deformation during storage before use, and can withstand rough handling during connection of other piping to it. The pipe assembly incorporating such pipe section is cost effectively fabricated in the field and has increased strength at the point of interface during the connection operation, with the result that such operation is made easier and more efficient. And, the method and apparatus for making the pipe section, as well as the method for making the aforementioned pipe assembly, of the invention are correspondingly convenient and cost effective.

Other objects and benefits of the invention will become apparent from the present specification, and the invention will be set forth in the claims.

#### Brief Description of the Drawings

Fig. 1 is a partly cut away elevational view of a pipe section of the invention.

Fig. 2 is a partially cut away elevational view of the connection between the male and female connection portions of two adjacent pipe sections according to the invention.

Fig. 3 is a cross sectional view taken through the centerline of the female connection portion of a pipe section according to the invention.

Fig. 4 shows an enlarged partial view of Fig. 3.

Figs. 5 to 10 are enlarged views similar to that of Fig. 4, showing alternate embodiments of the invention herein.

Fig. 11 is a cross-sectional view of a pipe section of the invention during manufacture.

Fig. 12 shows the initial fabricated female connection portion and a mandrel used to form it into the final desired structure of the invention.

Fig. 13 shows an apparatus for forming the reinforced rim structure in a pipe section.

Figs. 14-16 are detailed sectional views of mandrels for forming rim structures of alternate embodiments.

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### Detailed Description of Certain Preferred Embodiments of the Invention

A central feature of our invention is formation of the integral reinforcing member on the female end of a subject pipe section. This member reinforces the female end's peripheral edge so that it can withstand rough contact, jostling and the like when a male end of another pipe section is inserted and moved around to secure alignment pursuant to connection of the pipe sections. Typically, practice of the present invention results in attainment of a hoop strength at the reinforced female end of at least 10, and preferably at least 15, pounds (e.g. for 4-inch diameter conduit) and in some cases 50, and preferably at least 80, pounds (e.g., for 12-inch diameter conduit), hoop strength being defined as the amount of force needed to laterally compress a pipe by 5% of its diameter. Moreover, the reinforcing member strengthens the female end of a subject pipe section, especially when flared, against deformation resulting from flowering by providing a skeletal frame which holds the end in its desired shape. Also, the reinforcing member provides extra support while the pipe section is being stored, for example, stacked in contact with other pipe sections. In the event ambient conditions such as heat, sunlight or the like cause a softening of the pipe section's constituent material the reinforcing member contributes added structural integrity so that degradation which might otherwise occur can be prevented or at least decreased substantially.

25 While useful with a range of materials, the invention is especially applicable to piping made of polymeric materials such as polyethylene, polypropylene and PVC (in certain good embodiments, especially with polypropylene and PVC for instance, filler is also incorporated to reduce cost). Over and above such materials' intrinsic value in piping applications, they are particularly useful for producing piping in a 30 variety of shapes and styles, especially piping having a corrugated wall, which structure confers a relatively greater strength to weight ratio *vis-a-vis* non-corrugated piping. This is a consequence of the fact that the solidified polymeric materials of

which conduit is made characteristically are formed from precursors (such as the polymeric material at elevated temperature, e.g., hot polyethylene, or a reaction mixture subjected eventually to curing conditions) which have rheological properties permitting material flow until setting. Since such precursors are highly formable, the 5 polymeric materials are particularly useful in extrusion processes, and other processes which similarly require a high degree of formability, for making the corrugated pipe sections on other shapes and styles contemplated in connection with the present invention.

It follows that a preferred embodiment of the invention is a method of forming 10 a pipe section, which comprises subjecting an end of a length of polymeric material configured as a conduit with a corrugated wall to conditions sufficient to render the material proximate said end plastic; shaping the plastic polymeric material proximate said end into a flared portion; turning the plastic material at the end of said flared portion back away from the end to form an integral reinforcing structure.

15 The characteristics of the inventive pipe section as herein described lead to a highly advantageous pipe assembly comprising at least two pipe sections aligned and connected utilizing the invention. As brought out in more depth below, the present invention is very effective in maintaining the shape of a subject pipe section's female end so that a good fit between it and the male end of another pipe section can reliably 20 be achieved, without the necessity for mechanical working of such female end in order to return it to its initial configuration conforming to and accommodating the shape of the male end. Moreover, when the female end of a subject pipe section is flared, the reinforcing member has the further effects of dimensionally stabilizing the flared end (again for the purpose of reliably accommodating the other pipe section's 25 male end), and strengthening the edge of the flared portion so that movement therein of the other pipe section's end to achieve the desired alignment can be carried out with decreased danger of deformation of the flared portion through rough contact, etc.

It can, therefore, be seen that another preferred embodiment of the invention is that it involves a method of fabricating a pipe assembly as aforesaid. In this method 30 the pipe section is formed from a polymeric material, and it has a first tubular conduit. A female connection on the end of the conduit has a generally cylindrical or conical structure which extends from the end of the conduit.

The terminal portion of the end structure is then heated to make the material plastic. The terminal portion of the female connection and a mandrel are then pressed together. The mandrel has a pocket structure which causes the heated end of the female connection to bend backwards to form a reinforcing rim structure. The heated 5 end is then allowed to set. The cooled material of the rim structure reinforces the female connection so that the flowering and other deformation problems of the prior art are not encountered.

To provide an integrated treatment of various structural aspects of the invention, we consider a pipe assembly formed of at least first and second pipe 10 sections. The first pipe section comprises a tubular conduit with a female connection on the end. The second pipe section has a tubular conduit with a male connection on its end. The female connection receives the male connection so that the interior of the first pipe section communicates with the interior of the second pipe section, and water or other fluid can flow through the pipe assembly.

15 The female connection is formed of a polymeric material. It has a first connection portion which is connected to the end of the conduit and extends longitudinally away from it. The female connection also has an annular terminal edge which defines an opening at the end of the pipe section. The terminal edge has a reinforcement structure which rigidifies the end of the female connection and prevents 20 the flowering and other deformation problems of the prior art.

The reinforcement structure preferably includes a first annular portion formed integral with the first connection portion, a second annular portion formed integral with this portion and extending radially inwardly or outwardly of the first annular portion, and a third annular portion which is formed integral with the second annular 25 portion and extends longitudinally inwardly of the first pipe section.

In a preferred embodiment, the first pipe section has a corrugated outer structure of the same polymeric material as the female connection affixed to the outer surface of the conduit. Preferably, the corrugated outer surface is formed integral with the female connection portion and is of material which is substantially the same 30 thickness as in the female connection.

The female connection is also provided with a widening flared opening to aid assembly of the pipes in, for instance, a trench, where it is difficult to perfectly align the pipe sections for assembly. This is a valuable feature, since it is often fairly

difficult to align the pipes precisely before pressing them together; provision of a flared portion which helps guide another pipe section's end toward the female connection site expedites attaining alignment. In such connection, it should be noted that as used herein: the term "approximate registration" refers to the condition in 5 which two pipe sections are oriented vis-a-vis one another that the male end of one can be or is inserted into the flared female end of the other; and the term "alignment" refers to the condition of such section. The flare also enhances the structural strength of the end of the pipe section.

10 The rigidity of the female connection also may be enhanced by the use of several crimped or creased portions of the end portion which additionally reinforce the structure of the female connection.

Now, with reference to the figures of drawing, as best seen in Fig. 1, a pipe section, generally indicated at 3, extends longitudinally between a male end or spigot, generally indicated at 5, and a female end or bell, generally indicated at 7.

15 Intermediate these two ends is a middle length of the pipe section generally indicated at 9, which is shown in contracted cut-away in Figure 1. The usual length of the pipe sections of this type is about 20 feet, although there may be variations in this depending on the application and environment for which the use is desired. Inner diameters of the pipes may vary widely, but in the preferred embodiment range from 20 about 10 inches to about 37 inches.

25 The pipe section 3 has an outer structure 11 which is preferably formed of a continuous extrusion of polymer material, most preferably a thermoplastic such as high density polyethylene (HDPE). The outer structure 11 has a number of ring-shaped corrugations 13 each extending around the pipe. Alternatively, the outer structure may have a different pattern, such as spiral corrugations.

The inside of the pipe section 3 is a tubular or cylindrical conduit 15 which extends between the male and female ends 5 and 7 and which is bonded to the corrugated structure 11 during fabrication of the pipe section. The conduit is preferably also formed as a continuous extrusion of polymer material, most preferably 30 HDPE. This inner cylindrical conduit 15 defines a passage generally indicated 17 going through the pipe section from the male end 5 to the female end 7.

During assembly of the pipe sections, as best shown in Fig. 2, the male end 5 is inserted into the female connection 7. The female connection provides a inwardly

facing conical engagement surface 19 against which abuts a resilient sealing member 21, which is a gasket, preferably an extruded rubber profile, supported in a radially outwardly facing recess on the last corrugation 23 of the male end 5 of the pipe section 3. Alternatively, a gasket may be held in the valley 24 between the first and 5 second corrugations at the male end 5, which gasket is radially wide enough to sealingly engage surface 19. This engagement between the sealing member 21 and the engagement surface 19 effectively seals the joint so that fluids passing through the pipe sections do not leak out in appreciable amounts. The engagement surface 19 flares outwardly at an angle of 1° to 10°, and most preferably about 5°, to the 10 centerline axis of cylindrical conduit 15.

Fig. 3 shows an enlarged cross-section of the female connection 7. It will be understood that the cross section of the pipe section will be the same for all cross-sections through the centerline of the pipe because the form of the preferred embodiment is a shape of rotation with circular cross-sections. It will be understood 15 that non-circular cross-section pipes, e.g., oval cross-sections, may also benefit from the present invention.

After the last corrugation 13, the female connection end 7 comprises a bell structure 27 with an opening generally indicated at 25, into which the male end 5 can be inserted. The bell structure 27 comprises a generally conical flare portion 29 20 which tapers longitudinally outward and radially outward from the end 31 of the cylindrical conduit 15. This taper extends to the wall portion 33 which provides the inwardly facing engagement surface 19 against which the sealing member 21 of the male end 5 engages. Wall portion 33 tapers outward at an angle of about 1° to 10°, and most preferably about 5°, as indicated above.

25 Longitudinally outward of engagement surface 19, the wall portion 33 includes a further flared second flare section 35. This flare section 35 flares outward at a flare of about 15° to 30°, and most preferably about 20° from the centerline of the conduit 15 and preferably has a longitudinal length of about 1 to 2 inches, and most preferably 1.5 inches.

30 To rigidify the end opening 25 of female connection 7, the flare portion 35 is also provided with a plurality of small corrugations or crimps 37 which provide a ribbed annular portion which extends around the circumference of the conical flare section 35. In the preferred embodiment there are three crimps 37, but it will be

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understood that depending on the thickness of wall used and the length of this flare section 35, more or fewer crimps may be used.

Flare portion 35 is flared out at an angle of about 20°, which allows for insertion of the male end 5 into the female connection 7 with some degree of angular play. In common installation of such pipe sections, a trench is dug and the pipe section of 20 feet in length is lowered by the use of machinery such as a back hoe. As the pipe is lowered into the trench it may be fairly difficult to ensure that the axis of the second pipe section aligns with the axis of the first pipe section perfectly. The angulation of flare portion 35 allows for some play or tolerance in the alignment, in certain good embodiments up to as much as 20 or even 30° as the male end 5 is settled into the female connection 7.

The wall portion 33 extends to a longitudinal terminal end indicated at 39. This longitudinal terminal end 39 is provided with a reinforcing rim structure which keeps the shape of the mouth 25 of the female connection 7 circular.

As best seen in Fig. 4, the reinforcing structure comprises a first portion 41 formed integral with the distal end of the second flare portion 35. This first portion 41 extends longitudinally outward of the pipe section 3. Formed integral with the first section is a second section 43 which curves to extend radially outward from first portion 41. The third portion 45 is formed integral with second portion 43 and this extends backwards in a longitudinal direction towards the longitudinal center of the pipe section 3, spaced from the first portion 41. Third portion 45 has a terminal end portion 47 which is spaced from the first portion 41.

These annular structures combine to form an annular reinforcing structure which is roughly a U-shaped channel.

The U-shaped channel has a curved cross-section taken through the centerline of the pipe section. The radius of curvature of this channel is preferably about 1.25 times the thickness of the material of the flare portion, although the radius may be as large as 4 times the thickness of the material.

When the bell 7 is formed by extrusion it has a substantially uniform thickness throughout. The preferred thickness varies with the size of the pipe. A 12-inch diameter pipe will preferably have a thickness of about .110 to .112 inches. A 30-inch inside diameter pipe will preferably have thicker material, about .185 inches, and a 60-inch inside diameter pipe will preferably be of material about .25 inches thick.

The combination of the reinforcing structure and the 20° flare is remarkably sturdy, structure, as much as about five times stronger than the same pipe without the flare or reinforcement. A deformation test comparing two 12" pipes, one with a flare and reinforced rim as described herein, and the other identical, but with no rim or flare, yielded striking results. A 5% deformation of the unflared and unreinforced pipe required a compressive lateral load of 26 pounds. To achieve the same 5% deformation in the reinforced and flared pipe required a load of 122.5 pounds.

5 The curving structure of this reinforcing ring formed by the portions 41, 43 and 45 also provides an additional benefit in that no corners project either in a  
10 longitudinal direction or radially. During assembly of the female connection 7 with the male end 5, the roundness of all corners prevents the end portion 39 from catching the resilient sealing member 21 and dislodging it from its position on the first corrugation 23 in the male portion 5 and also significantly reduces the insertion force.

15 Figures 5 through 10 show alternate embodiments that can also be used to reinforce the end of the female connection 7. The same reference numbers are used for similar parts in these embodiments.

20 Figure 5 shows an alternate embodiment in which the third annular portion 45 is curved so that the terminal end 47 thereof contacts the outer side of flare portion 35. The result is that the reinforcing structure defined by the three elements of portions 41, 43 and 45 is a tubular structure reinforcing the rim of female connection portion 7.

In Figure 6, a further alternate embodiment is shown wherein the third portion 45 is pressed inward so that the third portion 45 lies adjacent to and engaging the first portion 41 on its radial outside surface.

25 Referring to Figure 7, a further alternate embodiment is shown wherein the curvature of the reinforcing structure at the end of the female connection 7 does not have a curvature as pronounced as that in the embodiment of Figure 5. Instead of having the curvature of approximately a complete semicircle, the embodiment of Figure 87 has a cross-section which is less than a semicircle and wherein the tangent to the terminal end portion 47 of the third portion 45 is at an angle  $\alpha$  from the  
30 perpendicular passing through the longitudinal axis of the pipe section. This angle  $\alpha$  is preferably less than 90° and more than about 10°, to produce some sort of channel structure in the rim. In the embodiment shown, the angle  $\alpha$  is about 60°.

Referring to Figure 8, an embodiment is shown wherein the third portion 45 of the reinforcing structure is connected to a further outwardly disposed portion 49 which engages and overlies the radially outer surface of third portion 45 so as to provide a generally S-shaped reinforcing structure at the mouth of female connection

5 7.

A further alternate embodiment is disclosed in Figure 9, wherein an annular bead 51 is formed around the outside of terminal end 53. This bead 51 is annular and reinforces outer rim 53 against deformation out of a desired shape in a fashion similar to the reinforcing structures of Figures 4 through 8.

10 This bead 51 may be formed by reforming the end of the extruded bell of female connection 7 without any additional material. An alternate possibility is that the bead 51, which is of the same material as used for the extrusion, which is preferentially high density polyethylene, is additional material applied around the longitudinal terminal end 53 of the formed flare portion 35. The application of this  
15 bead 51 is under conditions sufficient to cause it to fuse with the material of the flare portion 35 and structurally unite with that member. This bead may be applied as a string of polyethylene or other suitable material wrapped around the flare portion 35, or as a loop of polyethylene material which is shrunk around the flare portion 35.

It will be understood that reinforcement structures such as the bead need not  
20 be at the terminal end of the female connection, but may provide beneficial structural reinforcement when spaced slightly inward from the end, so long as the reinforcement is in the end region of the pipe to prevent deformation of the end.

It will also be understood that these embodiments are exemplary of reinforcement structures, and that other cross-sectional structures may be readily  
25 devised by those of skill in the art.

Figure 10 shows another alternative embodiment which can be applied not only to the rim structure indicated in Figure 4 but to the reinforcing rim structures of Figures 5 through 9, as well. As seen in Figure 10, the curvature of the reinforcing structure may be reversed so that it extends radially inwardly of the flared portion 35.  
30 In Figure 10, the reinforcing structure consists of a first portion 53 extending longitudinally outwardly, a second portion 55 extending radially inwardly and a third portion 57 which extends back longitudinally towards the longitudinal center of the

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pipe section 3. The inward terminal end 59 of this inward reinforcement structure is spaced inwardly from the first portion 53.

The configuration of this reinforcing structure may be varied so it can have a cross-section similar to that of the embodiment of Figure 6 (a tube structure), Figure 7 5 (a folded structure), Figure 8 (a less than semicircular arch), or Figure 9 (an S-shaped, folded structure). It will also be understood that the same concept can be applied to the structure of Figure 10, wherein the bead 51 would be mounted on the radial inside of the lip 53 of the mouth of the female connection.

The preferred method of manufacture of the pipe sections of the invention is 10 by extrusion of polymer material. Particularly preferred is the corrugated pipe extrusion method discussed in U.S. Patent 5,296,188, and/or embodied in the Corma, Inc., system sold under the model designation "3020".

Such a system produces a generally continuous corrugated tube which is cut into separate pipe sections.

15 Fig. 11 shows a segment of the continuous tube which is cut to form the male and female ends 5 and 7. The corrugated tube comprises two tubular parisons or sheets of extruded material, preferably of a thermoplastic nature, such as HDPE, which parisons have a substantially constant thickness over the length of the pipe. The outer parison 50 comprises the bell 7, including crimps 37, and the pipe structure 20 11 with the corrugations 13. The inner parison 60 is a generally cylindrical tube which constitutes the conduits 15 of the pipe sections 3. Both parisons are of the same material and are bonded together at annular regions 62 during the extrusion process.

The first step of processing after extrusion is that the pipe sections are cut to 25 separate them from each other. This is done by cutting completely through the extrusion at plane A of Figure 11.

The next step of processing involves cutting through each of the parisons 50 and 60 with a skiving tool, which is usually a router held in place to cut through one of the extruded parisons while the pipe section is rotated. Two cuts are made, inner 30 parison 60 being skived at plane B and outer parison 50 at plane C. This frees a portion, referred to as "top-hat" 64, which is recycled.

The resulting female end 7 has a cross-section as shown in Figure 12.

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As an alternative to this arrangement which requires skiving out the "top-hat" is that in the area of the bell the inner parison 60 may be pressed outward to form a double-walled bell shape. Such a structure would only require a single cut, to separate the pipe sections. The interior shape would be correct without further

5 skiving needed.

At this point, the pipe wall portion 33 has a longitudinal end 61 which extends generally along the line of the generally conical surface 19 of wall 33. It is this end 61 that is formed into the rim structure.

In order to introduce the rim structure, the female connection 7 and a mandrel

10 63 are pressed together so the mandrel enters into the opening 25 of the female connection 7.

As best seen in Figure 12, the mandrel 63 comprises a central body portion 65 which is generally circular about the central axis of the pipe section 3. This may be solid, or it may be toroidal, with a hole in the middle and a similar radially outward

15 configuration. The central portion 65 fits into the opening 25 at the end of the pipe section, and this first portion of the mandrel has a generally cylindrical outer wall 67. The cylindrical outer wall 67 blends into a flaring frustoconical wall 69, which flares outwardly at approximately 20° to impart a flare to the end structure 61 of the female connection 7.

20 The frustoconical surface 69 extends flaringly outward to pocket structure 71, which includes a curving surface 73 which curves from the outer end of the frustoconical section upwardly and then back in a longitudinal direction towards the end section of the pipe structure, forming an annular pocket or trough generally indicated at 75.

25 In this stage of fabrication, the thermoplastic material is either heated by a secondary source or the mandrel itself may be heated to soften this material and make it pliable to form the reinforcing structure. The softened end of the pipe is then pressed into the mandrel, by movement of either the pipe or the mandrel, or both together.

30 The engagement of the pipe with the mandrel is at specified temperature, pressure and duration. For a 12 inch inner diameter pipe with a 0.112 inch wall thickness, the end of the pipe is heated to about 350° F, and the mandrel and pipe are pressed together with a force of about 400 pounds. The engagement is maintained for

about 15 to 20 seconds, which imparts the proper shape to the pipe. These parameters, it will be understood, vary with the size of pipe, and may be varied even with the same size pipe.

An apparatus particularly preferred for finishing the female end 7 of the pipe 5 section 3 is shown in Figure 13. The female end 7 of the pipe is held in a rotary station indicated at 77 between rollers 79 and 81 that rotate the pipe 3 in place.

First, skiving device 83, which has two routing devices 85 and 87 mounted on a moving carriage, moves laterally to place the skiving device in operative position at the end 7 of the pipe 3. As the pipe is rotated, the top-hat (not shown in Figure 13) is 10 cut out. The skiving device 83 is then retracted to the position shown in Figure 13.

Mandrel device 89 then descends on vertical track 91 to line up with the end 7 of pipe 3. Heating device 93, preferably a gas torch or a quartz radiant heater, is then activated to heat and soften the material at the end of pipe 3. The mandrel 63 is supported on pneumatic cylinder structure 95, which, when activated, presses the 15 mandrel 63 into engagement with the end 7 of the pipe 3, forming the reinforcement structure on the pipe.

The mandrel 63 is then retracted and the mandrel device 89 moves up to its starting position shown in Figure 13.

The pipe is then cooled and allowed to set. Cooling may be assisted with an 20 air mister.

Other systems for pressing the engagement of the pipe end with the mandrel can readily be assembled by one of ordinary skill in the art. For example, a yoke that grips the end of the pipe may be attached to a pneumatic press with the mandrel thereon which, when activated, presses the mandrel against the end of the pipe.

25 Different mandrel designs can be used to obtain the rim structures of alternate embodiments shown in Figs. 5 to 10.

For example the embodiment of Figure 8 is preferably obtained by the mandrel arrangement as seen in Figure 14. Mandrel 97 has a sloping conical surface 99 which terminates at an abutment surface 101. A spot heating element 105 applies 30 heat to a middle third of the annular end portion 103 while the mandrel 97 and pipe 3 are being rotated relative thereto. As the end portion 103 is pushed against the abutment surface 101, the softened middle portion folds to form the S-shaped reinforcement.

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The radially inwardly disposed reinforcement structure shown in Figure 10 is preferably formed by a mandrel 107 as seen in Figure 9.

Figure 16 shows a preferred embodiment for formation of a bead 51 as seen in Figure 9. The mandrel 109 is rotated adjacent a rotating roller 111, which co-acts 5 therewith to shape the bead 51 at the end of pipe 3.

The terms used herein are intended to be terms of description rather than limitation, as those knowledgeable in the art with this specification in hand will be able to make modifications therein without departing from the spirit of the invention.

What is claimed is:

1. A pipe section which comprises a segment of polymeric material configured as a conduit having an end strengthened by a reinforcing structure formed integrally of said material around the periphery of said end, said structure including a portion which extends back away from said end.
2. A pipe section as defined in claim 1, wherein the reinforcing structure is formed at said end by turning the conduit material back over on itself.
3. A pipe section as defined in claim 1, wherein the hoop strength of said end is at least 10 pounds.
- 10 4. A pipe section as defined in claim 3, wherein the hoop strength of said end is at least 15 pounds.
5. A pipe section, which comprises a segment of polymeric material configured as a conduit with a corrugated wall, said conduit having an end portion which is flared, and which is strengthened by a reinforcing structure formed integrally of said material around the periphery of said end, said structure including a portion which extends back away from said end.
- 15 6. The pipe assembly of claim 5, wherein the flared portion flares at an angle of about 15° to 30° relative to the longitudinal axis of the conduit.
7. The pipe assembly of claim 6, wherein the angle is about 20°.
- 20 8. The pipe assembly of claim 5, wherein the flared portion includes at least one rigidifying crease structure, said crease structure being annular and extending substantially around the flared portion.
9. A pipe section comprising:  
inner and outer longitudinally extending generally tubular parisons each of  
25 high density polyethylene material and formed by extrusion, each parison having a  
respective substantially constant thickness throughout;  
the inner parison comprising a substantially cylindrical longitudinally  
extending conduit having a passage therein for fluids to pass through the pipe section,  
said conduit having two longitudinal ends and an outer surface;
- 30 said outer parison comprising a corrugated structure surrounding the conduit  
and affixed to the outer surface thereof and a bell structure formed integral with the  
corrugated structure adjacent one of the ends of the conduit and projecting  
longitudinally outward therefrom;

said corrugated structure having a male connection structure secured adjacent the other end of the conduit, said bell structure forming a female connection structure configured to sealingly receive therein another male connection structure having a configuration substantially the same as said male connection of the pipe section;

5        the bell structure comprising:

      a first flare section connected with the corrugated structure adjacent the associated end of the conduit and projecting longitudinally and radially outward therefrom, said flare section including a radially inwardly disposed generally conical engagement surface tapering outwardly at an angle of about 1 to 10° and configured

10      to sealingly engage said other male connection structure when placed in the bell structure;

      a second flare portion formed integral with and projecting radially and longitudinally outwardly from an outer end portion of the first flare portion and tapering outwardly at an angle of about 15 to 30° for a distance of about 1 to 2 inches;

15      said second flare portion including a longitudinal terminal end portion of the bell structure, said terminal end portion defining in the female connection a generally circular end opening communicating with the passage in the conduit;

      the terminal end portion including a reinforcement structure comprising  
      a first annular portion formed integral with the second flare portion and

20      extending longitudinally outwardly therefrom;

      a second annular portion formed integral with the first annular portion and extending radially outwardly therefrom;

      a third annular portion formed integral with the second annular portion and extending longitudinally inward therefrom;

25      said reinforcing structure being formed by shaping the terminal end portion to turn back on itself so that the reinforcing structure has a channel or tubular cross-section.

10.     A pipe assembly for accommodating fluid flow therethrough, which includes

30      a first pipe section comprising a length of polymeric material configured as a conduit and having a male end and a female end, said first pipe section's female end being flared and being strengthened by a reinforcing structure formed integrally of

said material around the periphery of said female end, said structure including a portion which extends back away from said end, and

a second pipe section comprising a length of polymeric material configured as a conduit and having a male end and a female end;

5        said male end of said second pipe section being in the female end of the first pipe section such that fluid may flow from one of said sections into the other.

11.    A pipe assembly comprising:

      first and second pipe sections;

      the first pipe section comprising a longitudinally extending tubular first 10 conduit portion having a longitudinal end and a female connection portion on said end, said female connection portion having a first opening therein and said conduit portion having a passage therein communicating with the first opening;

      the second pipe section comprising a longitudinally extending tubular second conduit portion with a longitudinal end and a male connection portion on said end, 15 said male connection having a second opening therein and the second conduit portion having a passage therein communicating with the second opening;

      said female connection portion receiving the male connection portion therein so that the passage in the first pipe section communicates with the passage in the second pipe section and so that fluid can move through the pipe assembly by passing 20 through said conduit portions and said connection portions;

      said female connection portion comprising a first connection portion connected with the end of the conduit portion and extending in a longitudinal direction therefrom, said female connection portion including a longitudinal annular terminal end portion extending around said first opening and including a first annular 25 portion formed integral with the first connection portion and extending therefrom generally longitudinally outwardly of the first pipe section;

      a second annular portion formed integral with the first annular portion and extending generally radially inwardly or outwardly from the first annular portion; and

      a third annular portion formed integral with the second annular portion and 30 extending longitudinally inwardly of the first pipe section therefrom;

      said first, second and third annular portions together forming a generally circular reinforcement structure which strengthens the terminal end portion to preserve a circular shape thereof.

12. The pipe assembly of claim 11, wherein the first pipe section further comprises a corrugated outer structure, the first conduit portion having an outer surface, said corrugated outer structure surrounding and being affixed to said outer surface.

5 13. The pipe assembly of claim 12, wherein said corrugated outer structure is of the polymeric material, said corrugated outer structure being formed integral with said female connection portion, the corrugated outer structure and the female connection portion having a substantially uniform thickness.

10 14. The pipe assembly of claim 11, wherein said first connection portion includes a flare portion adjacent the terminal edge portion, said flare portion flaring radially outwardly and longitudinally outwardly of the first pipe section, thereby facilitating alignment of the first and second pipe section during assembly of the pipe assembly.

15 15. The pipe assembly of claim 11, wherein said second annular portion extends radially inwardly from the first annular portion and supports the third annular portion radially inwardly of the first annular portion.

16. The pipe assembly of claim 11, wherein said second annular portion extends radially outwardly from the first annular portion and supports the third annular portion radially outwardly of the first annular portion.

20 17. The pipe assembly of claim 11, wherein the third annular portion has a terminal end directed longitudinally inwardly of the first pipe section.

18. The pipe assembly of claim 17 and  
said first connection portion providing a radially inward facing engagement surface, and said male connection portion supporting thereon a gasket, said gasket  
25 engaging the engagement surface so as to substantially seal the connection between the male and female connection portions to resist escape of fluid from inside said pipe assembly; and  
said first, second, and third annular portions being curvingly configured so that the terminal end portion of the female connection portion has no corners directed  
30 radially inwardly and longitudinally outwardly of the first pipe section that could contact and dislodge the resilient seal member from the male connection portion during assembly of the first and second pipe sections.

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19. The pipe assembly of claim 11, wherein said polymeric material is high density polyethylene.

20. The pipe assembly of claim 12, wherein the corrugated outer structure and the first conduit portion are formed simultaneously by extrusion of thermoplastic material.

5 21. The pipe assembly of claim 11, and  
said female connection portion being formed by extrusion of thermoplastic material.

22. A pipe section comprising:  
10 a longitudinally extending tubular first conduit portion having a longitudinal end and a female connection portion on said end, said female connection portion having a first opening therein and said conduit portion having a passage therein communicating with the first opening;

the female connection portion being adapted to receive therein in said opening  
15 a male connection of a second pipe section;

said female connection portion being formed as an extrusion of polyethylene material having a substantially constant thickness throughout, said female connection portion comprising a first connection portion connected with the end of the conduit portion and extending generally in a longitudinal direction therefrom, and an annular  
20 longitudinal terminal end portion extending around said first opening, said longitudinal terminal end portion including a generally annular reinforcement structure formed integral with and around the terminal edge portion, which reinforcement structure strengthens the terminal end portion to preserve the shape thereof and of the first opening.

25 23. The pipe section of claim 22, wherein the first pipe section further comprises a corrugated outer structure, the first conduit portion having an outer surface, said corrugated outer structure surrounding and being affixed to said outer surface.

30 24. The pipe section of claim 23, wherein said corrugated outer structure is extruded of polyethylene material, said corrugated outer structure being formed integral with said female connection portion.

25. The pipe section of claim 22, wherein said first connection portion includes an angulated flare portion supporting the terminal edge portion, said flare

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portion flaring radially outwardly and longitudinally outwardly of the first pipe section adjacent the terminal edge portion.

26. The pipe section of claim 25, wherein the flare portion flares at an angle of about 15° to 30° relative to the axis of the first conduit portion.

5 27. The pipe section of claim 26, wherein the flare portion flares at an angle of about 20° relative to the axis of the first conduit portion.

28. The pipe section of claim 25, wherein the flare portion includes at least one rigidifying crease structure, said crease structure being annular and extending substantially around the flare portion.

10 29. The pipe section of claim 25, wherein said reinforcement structure extends radially inwardly from the terminal end portion.

30. The pipe section of claim 25, wherein said reinforcement structure extends radially outwardly from the terminal end portion.

31. The pipe assembly of claim 21 and

15 said first connection portion providing a radially inward facing engagement surface adapted to engage a resilient sealing member supported on said male connection portion so as to substantially seal the connection between the male and female connection portions to resist escape of fluid from inside said pipe assembly and resist flow of external fluids into the pipe assembly; and

20 said reinforcement structure being curvingly configured so that the terminal end portion of the female connection portion has no corners directed radially inwardly and longitudinally outwardly of the first pipe section that could contact and dislodge the resilient seal member from the male connection portion during assembly of the first and second pipe sections.

25 32. The pipe assembly of claim 21, wherein the reinforcement structure has a cross section taken through the axis of the conduit portion which cross-section is a channel shape.

33. The pipe assembly of claim 21, wherein the reinforcement structure has a cross section taken through the axis of the conduit portion which cross-section is a 30 U-shape.

34. The pipe assembly of claim 21, wherein the reinforcement structure has a cross section taken through the axis of the conduit portion which cross-section is an arcuate shape of between 100° and 180°.

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35. The pipe assembly of claim 21, wherein the reinforcement structure has a cross section taken through the axis of the conduit portion which cross-section is a tubular configuration.

36. The pipe assembly of claim 21, wherein the reinforcement structure has 5 a cross section taken through the axis of the conduit portion which cross-section is an S-shape.

37. The pipe assembly of claim 21, wherein the reinforcement structure has a cross section taken through the axis of the conduit portion which cross-section is that of a substantially solid bead of material.

10 38. A pipe assembly comprising:

a first pipe section;

the first pipe section comprising a longitudinally extending tubular first conduit portion having a longitudinal end and a female connection portion on said end, said female connection portion having a first opening therein and said conduit 15 portion having a passage therein communicating with the first opening;

the female connection portion being adapted to receive therein in said opening a male connection of a second pipe section;

said female connection portion comprising

20 a first connection portion connected with the end of the conduit portion and extending generally in a longitudinal direction therefrom, and

a flare portion extending from the first connection portion and being angulated with respect thereto so that said flare portion tapers radially and longitudinally outwardly of the first connection portion;

25 said flare portion including an annular longitudinal terminal end portion distal to the conduit portion and extending around said first opening;

said longitudinal terminal end portion including a generally annular reinforcement structure formed integral therewith, which reinforcement structure strengthens the terminal end portion to preserve the shape thereof and of the first opening.

30 39. The pipe assembly of claim 38, wherein the first pipe section further comprises a corrugated outer structure, the first conduit portion having an outer surface, said corrugated outer structure surrounding and being affixed to said outer surface.

40. The pipe assembly of claim 39, wherein said corrugated outer structure and the female connection portion are extruded of polyethylene material, said corrugated outer structure being formed integral with said female connection portion.

5 41. The pipe assembly of claim 38, wherein the flare portion flares at an angle of about 15° to 30° relative to the axis of the first conduit portion.

42. The pipe assembly of claim 41, wherein the flare portion flares at an angle of about 20° relative to the axis of the first conduit portion.

10 43. The pipe assembly of claim 38, wherein the flare portion includes at least one rigidifying crease structure, said crease structure being annular and extending substantially around the flared portion.

44. The pipe assembly of claim 38, wherein said reinforcement structure extends radially inwardly from the terminal end portion.

45. The pipe assembly of claim 38, wherein said reinforcement structure extends radially outwardly from the terminal end portion.

15 46. The pipe assembly of claim 38, and

46. said first connection portion providing a radially inward facing engagement surface adapted to engage a resilient sealing member supported on said male connection portion so as to substantially seal the connection between the male and female connection portions to resist escape of fluid from inside said pipe 20 assembly; and

said reinforcement structure being curvingly configured so that the terminal end portion of the female connection portion has no corners directed radially inwardly and longitudinally outwardly of the first pipe section that could contact and dislodge the resilient seal member from the male connection portion during assembly of the 25 first and second pipe sections.

47. The pipe assembly of claim 38, wherein the reinforcement structure has a cross section taken through the axis of the conduit portion which cross-section is a channel shape.

30 48. The pipe assembly of claim 38, wherein the reinforcement structure has a cross section taken through the axis of the conduit portion which cross-section is a U-shape.

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49. The pipe assembly of claim 38, wherein the reinforcement structure has a cross section taken through the axis of the conduit portion which cross-section is an arcuate shape of between about 100° and 180°.

50. The pipe assembly of claim 38, wherein the reinforcement structure has  
5 a cross section taken through the axis of the conduit portion which cross-section is a tubular configuration.

51. The pipe assembly of claim 38, wherein the reinforcement structure has a cross section taken through the axis of the conduit portion which cross-section is an S-shape.

10 52. The pipe assembly of claim 38, wherein the reinforcement structure has a cross section taken through the axis of the conduit portion which cross-section is that of a substantially solid bead of material.

53. A method of forming a pipe section, which comprises  
subjecting an end of a segment of polymeric material configured as a conduit  
15 to conditions sufficient to render the material proximate such end plastic;  
turning the plastic polymeric material at such end back away from the end to form an integral reinforcing structure.

54. A method of forming a pipe section, which comprises  
subjecting an end of a segment of polymeric material configured as a conduit  
20 with a corrugated wall to conditions sufficient to render the material proximate said end plastic;  
shaping the plastic polymeric material proximate said end into a flared portion;  
turning the plastic material at the end of said flared portion back away from  
25 the end to form an integral reinforcing structure.

55. A process for extruding a pipe section, said process comprising:  
continuously extruding a corrugated pipe extrusion of a polyethylene material,  
said extrusion comprising inner and outer parisons, said inner parison being a  
continuous cylinder having an interior passage and an outer surface, the outer parison  
30 having at least two corrugated structures and a bell portion therebetween extruded  
continuously, the corrugated structures each being affixed to the outer surface of the  
inner parison;

circumferentially cutting both parisons of said extrusion between said bell portion and one of the corrugated structures to produce a pipe segment having a single bell portion and a single corrugated structure;

circumferentially cutting said outer parison of the pipe segment in said bell

5 portion and circumferentially cutting said inner parison adjacent the corrugated structure so that said bell portion has generally conical portion defining a concave opening in the bell portion communicating with the interior of the inner parison;

pressing said annular end portion in engagement with a mandrel, said mandrel engaging the end portion of the bell structure and re-shaping the conical portion to

10 have a flare portion adjacent the annular end portion, said flare portion being generally conical and tapering outwardly at an angle of about 20°mm;

said engaging with the mandrel causing said annular end portion to turn back radially outward of the flare portion and form a lip structure having a general channel shaped cross-section on the end of the bell portion;

15 allowing the polyethylene material to set so that said lip structure reinforces said opening to retain a circular shape.

56. The method of claim 55 and further comprising

heating the terminal end portion of the bell structure prior to engagement with the mandrel.

20 57. The method of claim 56, and said mandrel being heated to heat the end of the bell structure.

58. A method of fabricating a pipe assembly, said method comprising:

forming a female connection portion for a pipe section from a polymeric material by extrusion, said pipe section including a first tubular conduit portion

25 having an interior passage therein and a longitudinal end with an opening communicating with the passage;

the female connection portion having a generally tubular end structure having a first connection portion for connection with the end of the conduit portion, said end structure having a longitudinal terminal portion distal from the first connection

30 portion, said end structure having a substantially constant wall thickness;

heating the longitudinal terminal portion of the end structure to become plastic; and

pressing engagement between the longitudinal terminal portion and a mandrel, said mandrel being configured so that engagement of the mandrel with the end structure of the female connector portion causes the plastic terminal end portion of the female connector portion to form a reinforcing structure therein; and

5 causing the polymer material of the female connector portion to set so that said reinforcing structure reinforces said female connector portion retaining its shape.

59. The method of claim 55 and

said end structure being formed conical and extending flaringly outwardly from the first connection portion at an angle of about 1° to 10°.

10 60. The method of claim 59 and  
said flare angle being about 5°.

61. The method of claim 58 and

said end structure being formed conical and extending flaringly outwardly from the first connection portion at an angle of about 15° to 30°.

15 62. The method of claim 61 and  
said angle being about 20°.

63. The method of claim 58, and

said mandrel having a central body portion which extends in a first direction into said end structure and an annular pocket structure extending around said central 20 body portion, said pocket structure having a first pocket portion projecting radially outwardly from the central body portion and a second pocket portion extending in said first direction and spaced radially outward of the central body portion, said first and second pocket portions and the central body portion defining therebetween an annular recess around the central body portion;

25 said terminal end portion being formed with reinforcing crease structures rigidifying the flared shape of the female connection portion.

64. The method of claim 63 and

said central body portion of the mandrel having a conical or frustoconical flaring surface adjacent the pocket structure, said flaring surface tapering inwardly 30 away from the pocket structure so that said terminal end portion of the female connector portion is given an outwardly flared shape adjacent said reinforcing structure.

65. The method of claim 58 and

said polymer material being a thermoplastic.

66. The method of claim 65 and  
said polymer material being high density polyethylene.

67. The method of claim 58 and  
5 said heating of the terminal end portion being achieved by heating of the  
mandrel.

68. The method of claim 58 and  
said heating of the terminal end portion being performed by a secondary heat  
source, and said mandrel being cooled to cause the setting of the material.

10 69. A method of fabricating a pipe assembly for accommodating fluid flow  
therethrough, said assembly including a first pipe section comprising a length of  
polymeric material configured as a conduit and having a male end and a female end,  
said female end being flared and being strengthened by a reinforcing structure  
formed integrally of said material around the periphery of said female end, said  
15 structure including a portion which extends back away from said end, and a second  
pipe section comprising a length of polymeric material configured as a conduit and  
having a male end and a female end, which method comprises  
bringing the female end of said first pipe section and the male end of said  
second pipe section into approximate registration by inserting the male end of the  
20 second pipe into the reinforced flared female end of the first pipe section, and  
connecting the male end of the second pipe section and the female end of the  
first pipe section when the two sections are in alignment, such that fluid may flow  
from one of said sections into the other.

70. A method of fabricating a pipe assembly, said method comprising:  
25 forming a pipe section from a polymeric material by extrusion, said pipe  
section including a first generally cylindrical conduit portion having an interior  
passage therein and longitudinal end with an opening communication with the  
passage, and a female connection portion on the end of the conduit portion, the female  
connection portion having a generally cylindrical or conical end structure connected  
30 with and extending from the end of the conduit portion, said conical end structure  
having a longitudinal terminal portion distal from the end of the conduit portion, said  
end structure having a substantially constant wall thickness; and

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applying an annular bead of polymer material to said terminal end portion, said annular bead reinforcing said end portion to maintain a circular shape.

71. Apparatus for forming a reinforcing structure on an open end of a polymeric pipe section, which comprises

5 a mandrel having a wall for contacting said pipe section, said mandrel including a first portion wherein said wall is configured to be received in the open end of the pipe section, and another portion in which said wall extends outwardly of said first portion in arcuate fashion such that an annular pocket is formed;

means for holding said pipe section in an orientation such that it and said  
10 mandrel can be brought into contact, with the mandrel's first portion being that part of it first received in the opening at the end of the pipe section;

means for causing movement of the mandrel and the pipe section holding  
means relative to one another such that the mandrel and the pipe section come  
together with the mandrel's first portion being received by the opening at the end of  
15 the pipe section and thereafter the annular pocket of the third portion coming into  
contact with and deforming the end of the pipe section to form a reinforcing structure.

72. Apparatus as defined in claim 71, wherein said mandrel includes a  
second portion intermediate said first portion and said other portion, said second  
portion having a wall which flares outwardly in respect of said first portion such that  
20 when the second portion is brought into contact with the pipe section a part of said  
pipe section proximate the end is caused to flare outwardly.

73. The pipe assembly as defined in claim 31, wherein said connection  
resists flow of external fluids into the pipe assembly.

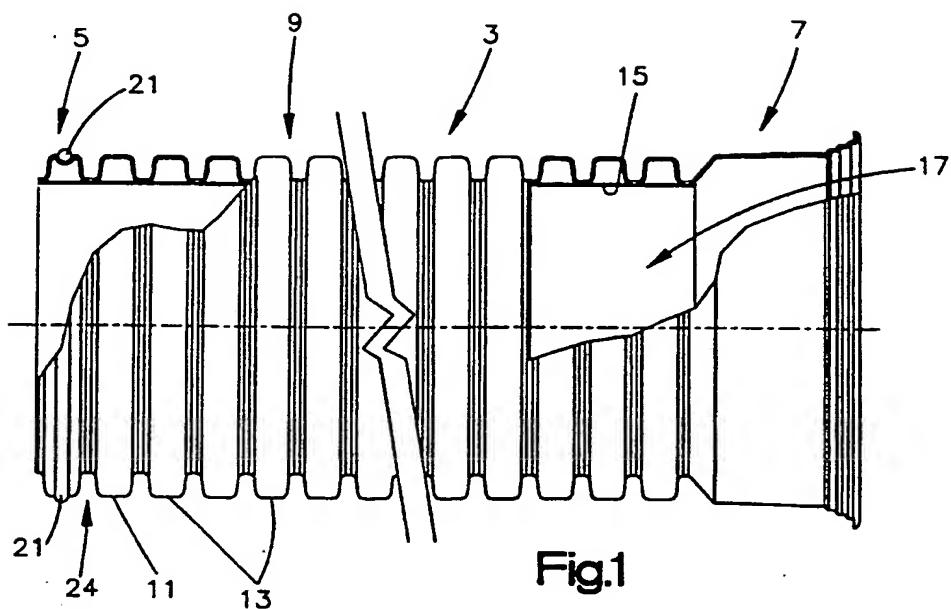


Fig.1

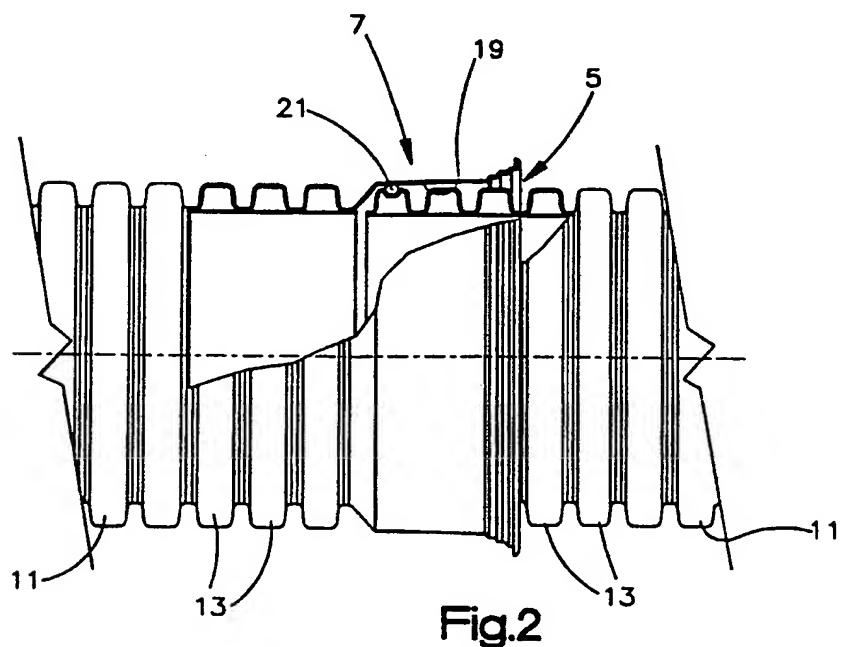


Fig.2

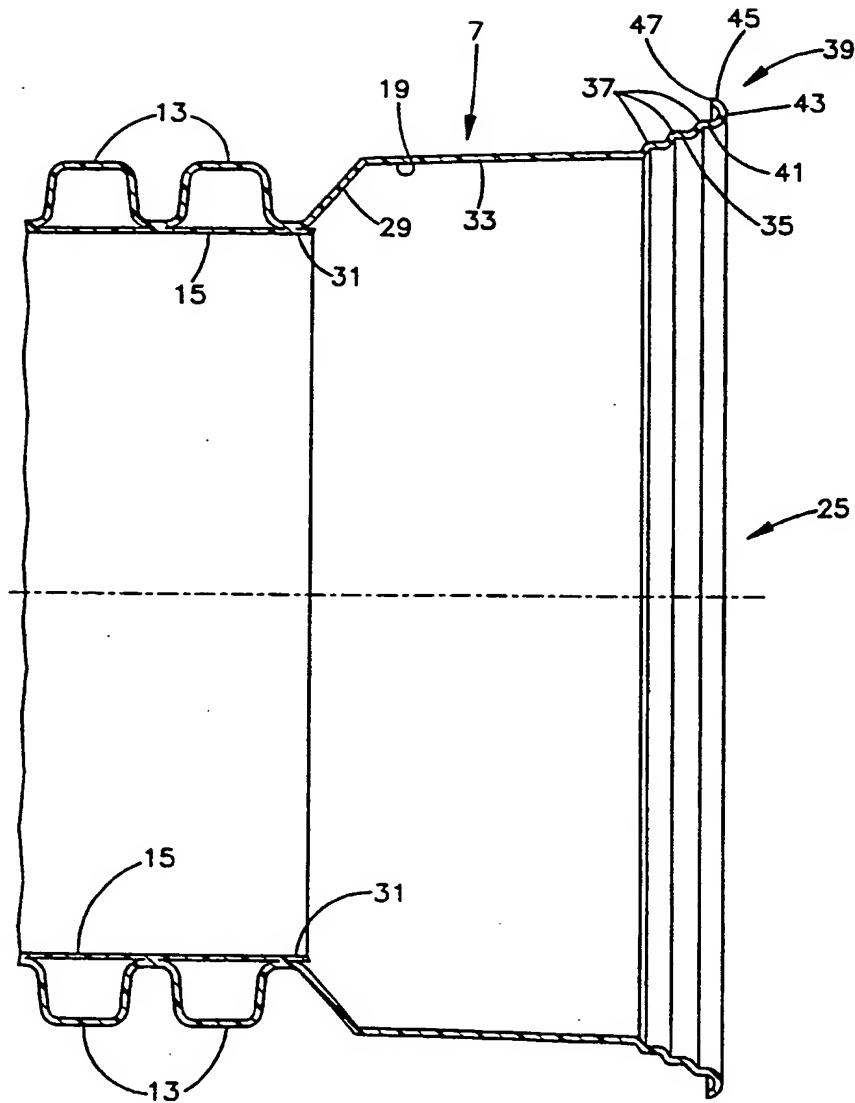


Fig.3

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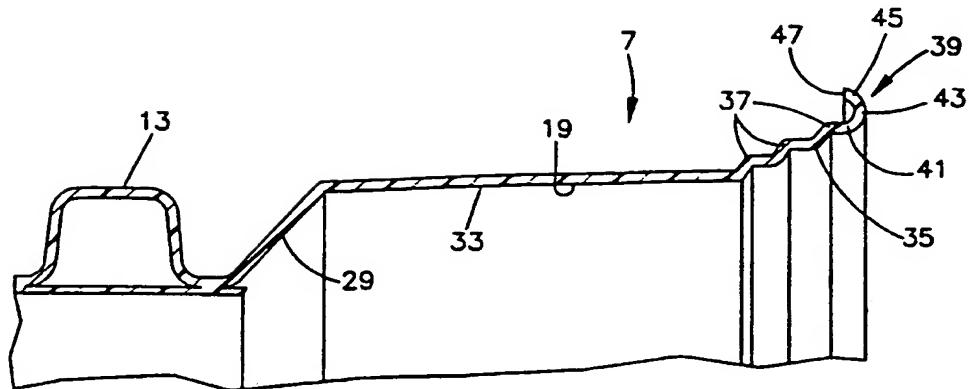


Fig.4

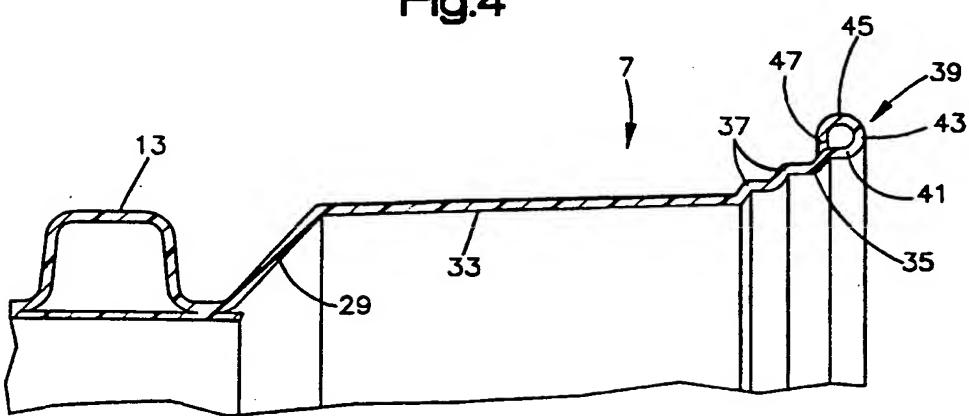


Fig.5

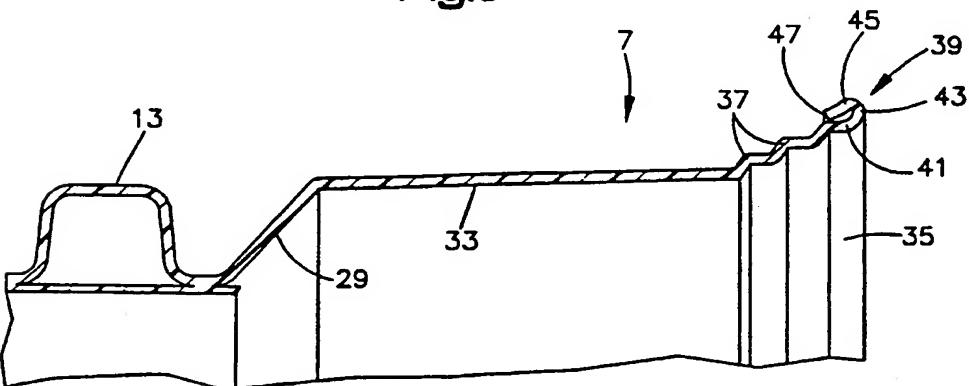


Fig.6

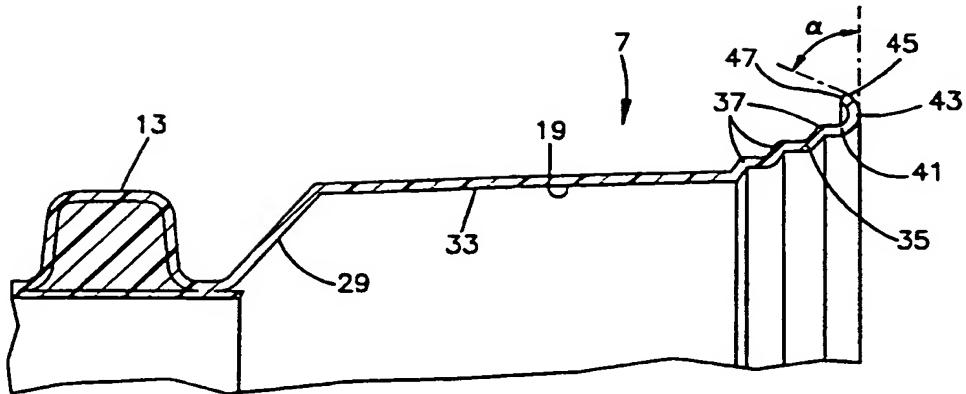


Fig.7

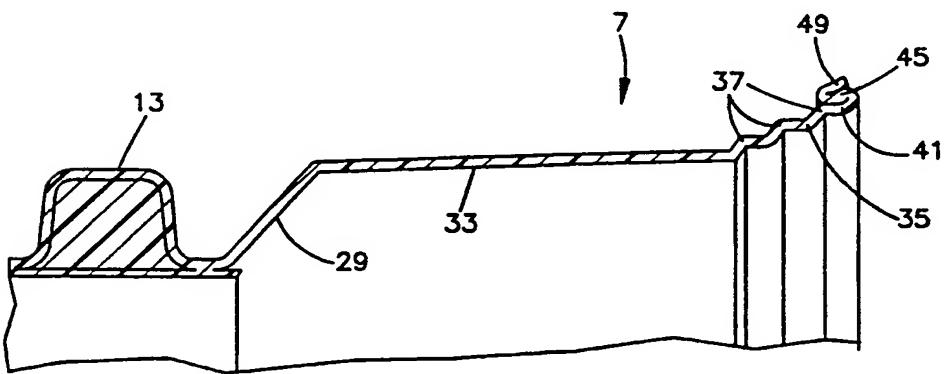


Fig.8

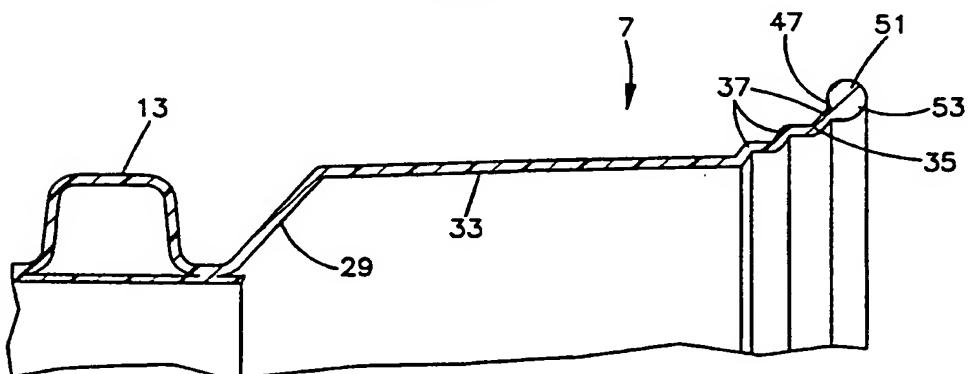


Fig.9

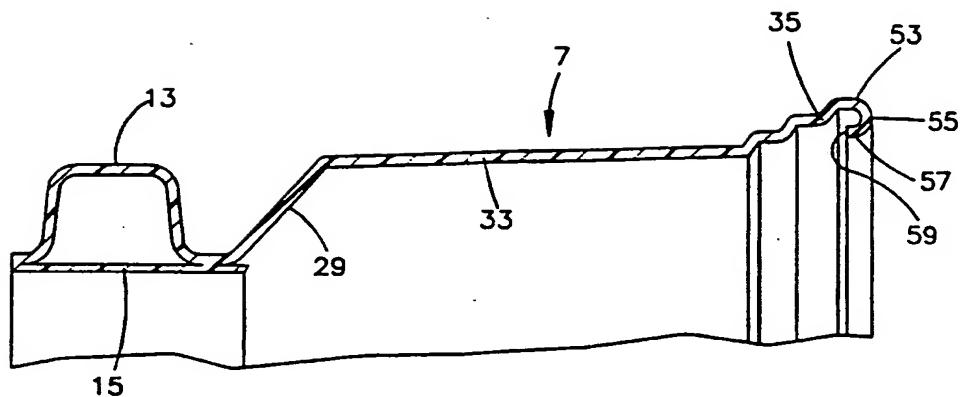


Fig.10

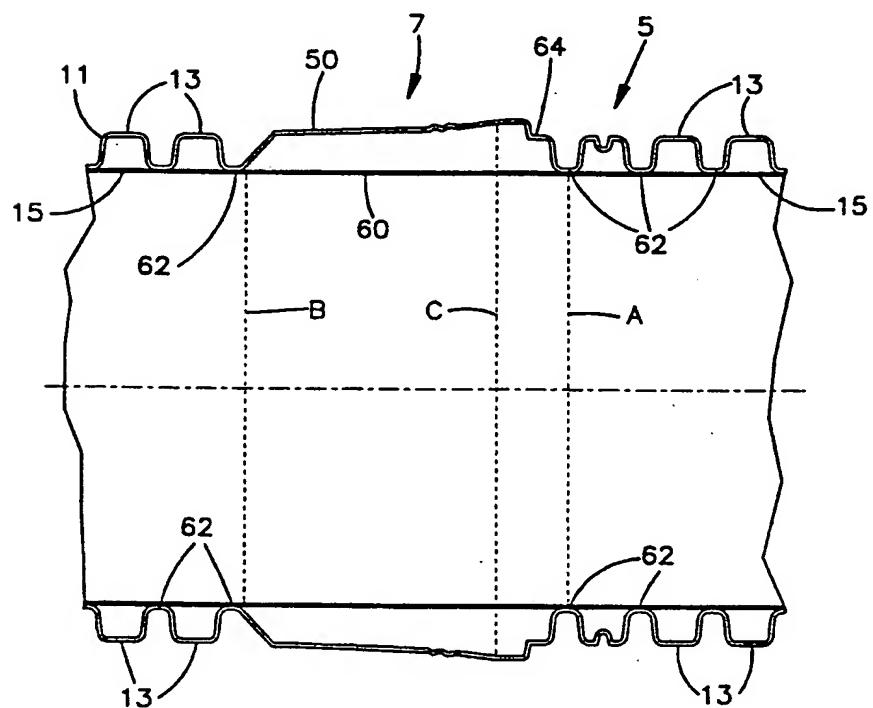


Fig.11

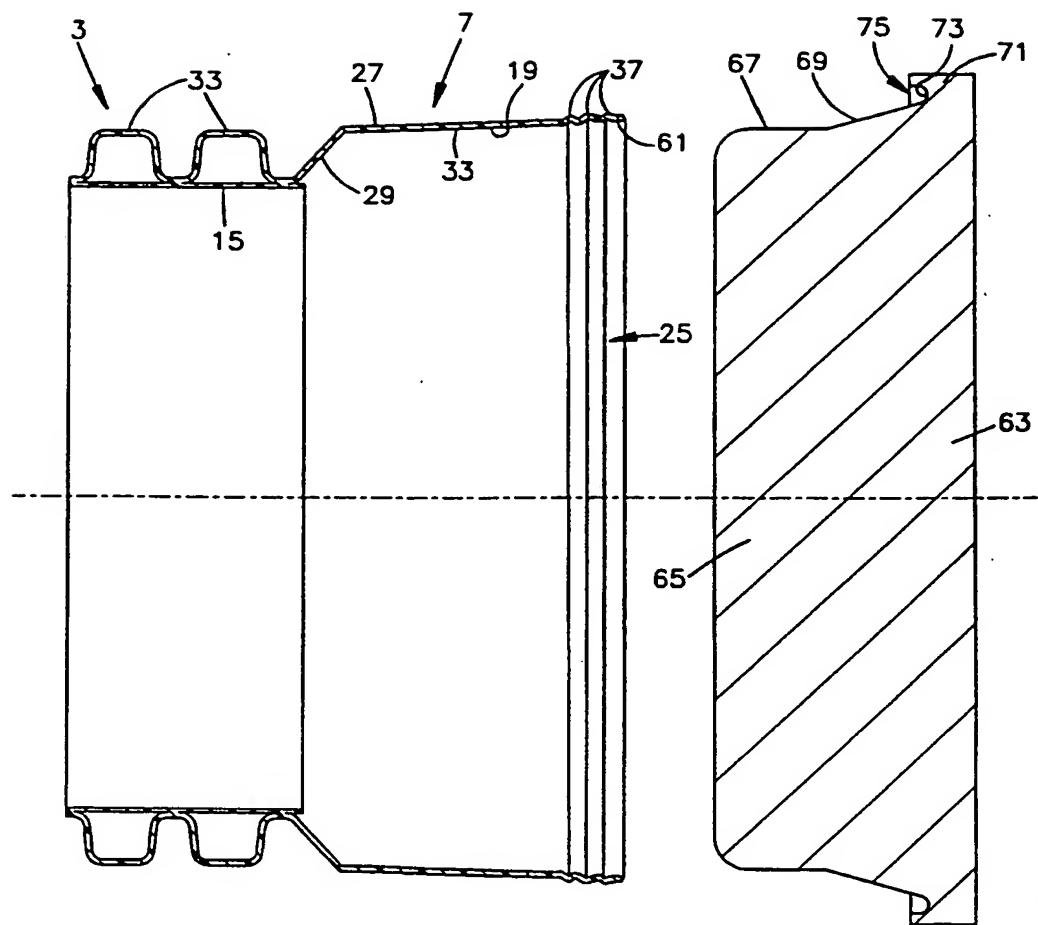


Fig.12

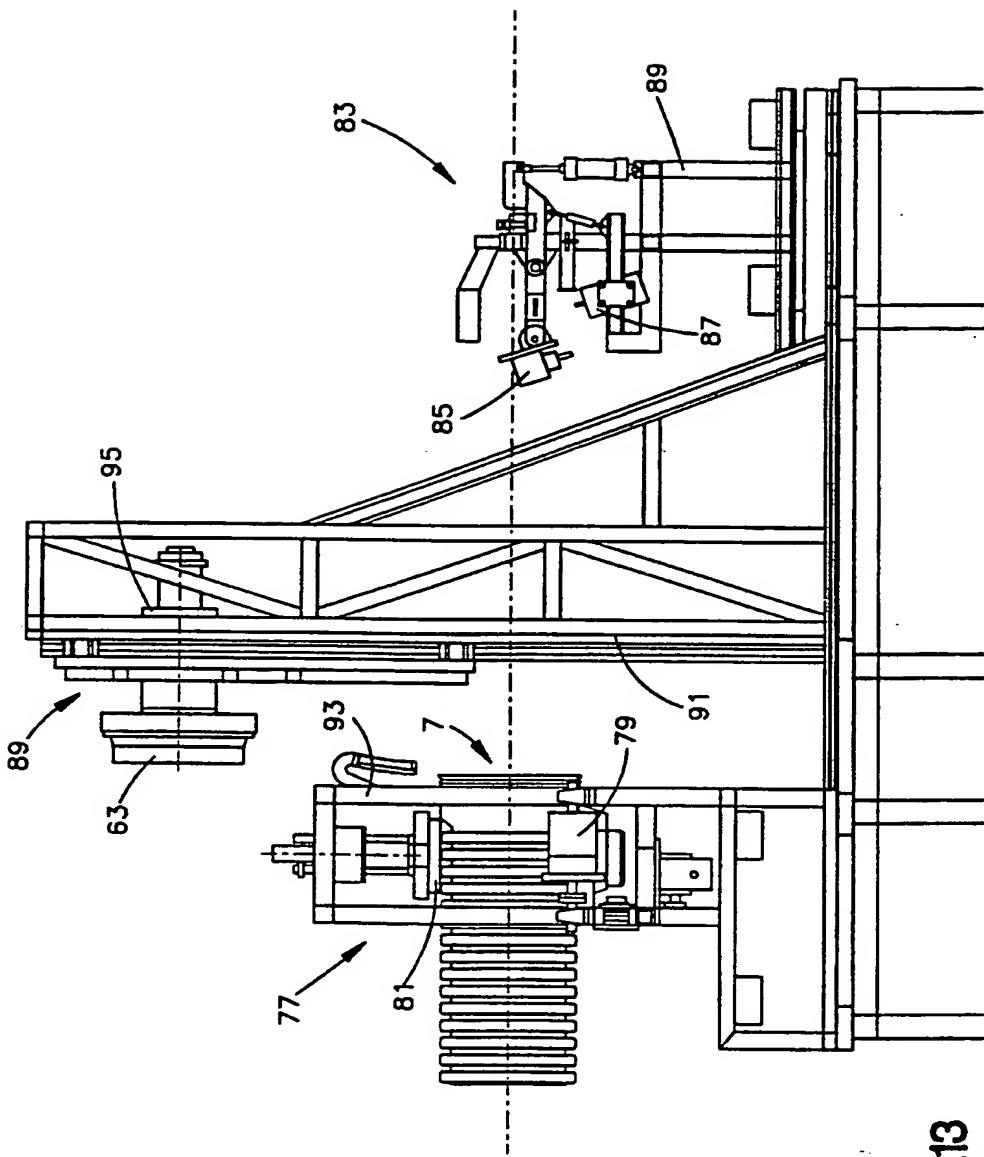


Fig.13

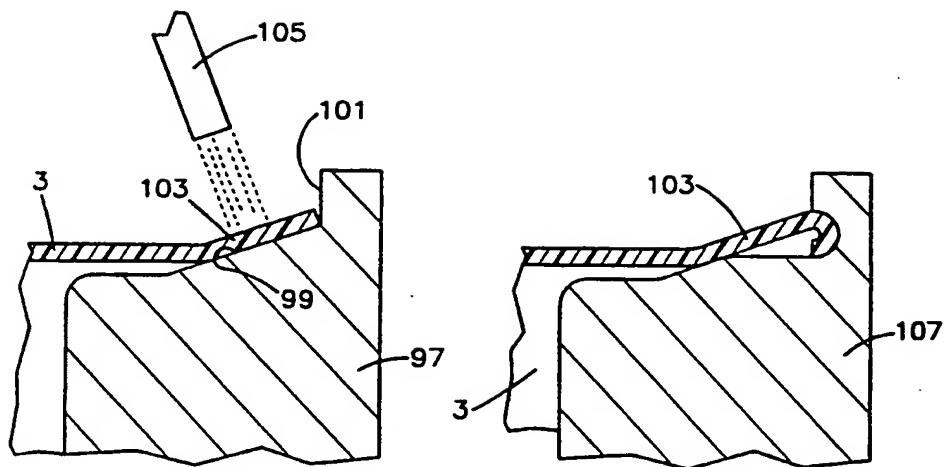


Fig.14

Fig.15

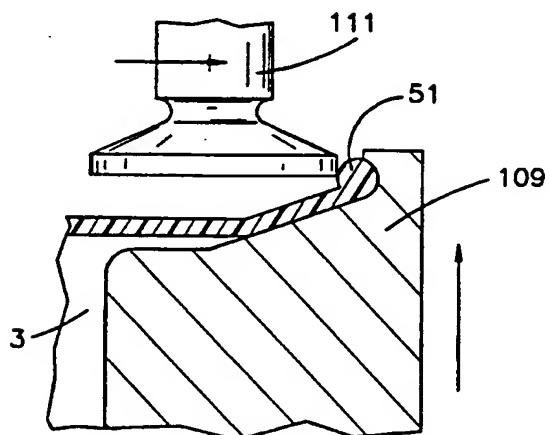


Fig.16

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(71) Applicant: HANCOR, INC. [US/US]; 401 Olive Street, Findlay, OH 45839-1047 (US).

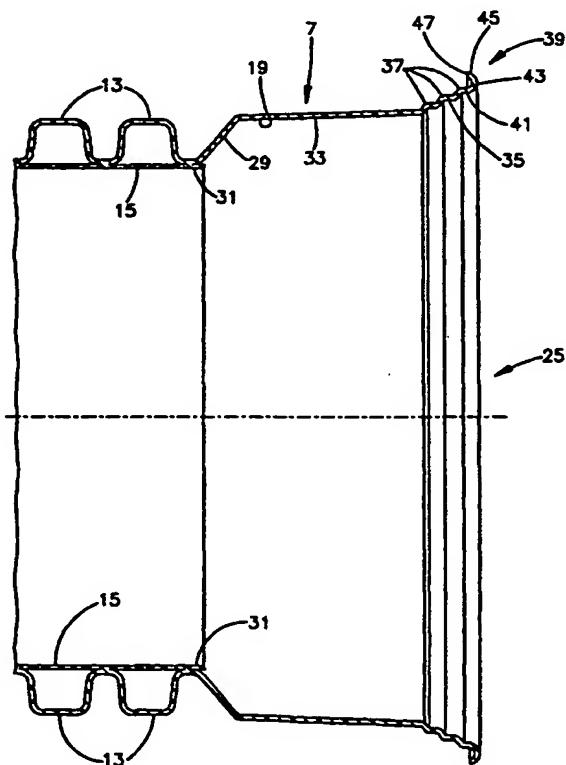
(72) Inventors: SIFERD, Roger, Lee; 11029 TR 180, Findlay, OH 45840 (US). ANKROM, Matthew, C.; 706

*[Continued on next page]*

(54) Title: PIPE STRUCTURE AND METHOD OF MANUFACTURE



**WO 00/46005 A3**



(57) Abstract: A pipe section (3) formed of a polymeric material which has a substantially constant thickness throughout, the terminal edge (39) of the female connection (7) having a reinforcement structure (41, 43 and 45) which rigidifies the end of the female connection (7) and prevents deformation, the pipe section preferably having a flared end, and the reinforcement structure preferably being a semicircular channel formed at the end of the pipe section by a mandrel (63) after initial extrusion of the pipe section; along with a method and apparatus for forming the pipe section, a pipe assembly including such pipe section, and a method of forming the pipe assembly.



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## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :F16L 9/00; B29C 15/00  
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## B. FIELDS SEARCHED

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U.S. : 138/109, 121, 155, 120, 173, 172; 285/903, 138.1; 425/392, 393; 264/296, 322

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,779,651 A (HEGLER et al) 25 October 1988, entire document.	38, 39 & 41-43
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A	US 4,968,241 A (DARLING) 06 November 1990, entire document.	71 & 72
A	US 4,379,115 A (SEACH et al) 05 April 1983, entire document.	53-70

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Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Authorized officer

PATRICK F. BRINSON

*Diane Smith Jr.*

Facsimile No. (703) 305-3230

Telephone No. (703) 308-0111

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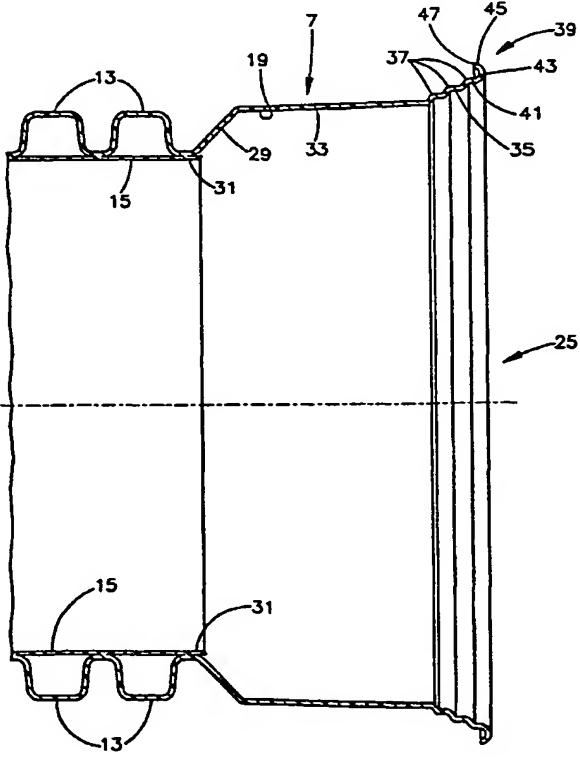
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Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Faxsimile No. (703) 305-3230

Authorized officer  
*J. Hurler for*  
PATRICK P. BRINSON

Telephone No. (703) 308-0111